

Notice of Allowability

Application No.

10/671,333

Applicant(s)

BALIGA, BANTVAL JAYANT

Examiner

Art Unit

Remmon R. Fordé

2826

AC

-- **Th MAILING DATE of this communication appears on the cover sheet with the corresponding address--**

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 6/15/04.
2. ☒ The allowed claim(s) is/are 28-40 (respectively renumbered as 1-13).
3. ☒ The drawings filed on 14 January 2004 are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08),
Paper No./Mail Date 6/2/04
4. ☐ Examiner's Comment Regarding Requirement for Deposit
of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413),
Paper No./Mail Date _____
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____

Minhloan Tran
Minhloan Tran
Primary Examiner
Art Unit 2826

DETAILED ACTION

Reasons For Allowance

Claims 28-40 are allowed.

The following is an examiner's statement of reasons for allowance:

Claim 28 recites a semiconductor device structure including the specific structural limitations of providing that a semiconductor substrate having a drift region of first conductivity type therein and transition region of first conductivity type that extends between the drift region and a first surface of the semiconductor substrate and has a vertically retrograded first conductivity type doping profile therein that peaks at a first depth relative to the first surface; first and second shielding regions of second conductivity type that extend in the drift region and define respective P-N junctions with the transition region, the first and second shielding regions extending laterally towards each other in a manner that constricts a neck of the transition region to a minimum width at a second depth relative to the first surface. The abovementioned structural limitations are neither anticipated by nor obvious over the prior art of record. Likewise, claims 29 and 30 are also allowable as being dependent upon allowable claim 28.

Claim 31 recites a vertical power device structure including the specific structural limitations of providing that a semiconductor substrate having a drift region of first conductivity type therein and a transition region of first conductivity type that extends between the drift region and a first surface of the semiconductor substrate, the transition region having a vertically retrograded first conductivity type doping profile therein that

peaks at a first depth relative to the first surface; first and second base regions of second conductivity type that extend in the semiconductor substrate and define respective P-N junctions with opposing sides of the transition region; first and second source regions of first conductivity type in the first and second base regions, respectively; first and second base shielding regions of second conductivity type that are more highly doped than the first and second base regions and extend laterally towards each other in the semiconductor substrate to thereby constrict a neck of the transition region to a minimum width at a second depth relative to the first surface. The abovementioned structural limitations are neither anticipated by nor obvious over the prior art of record. Likewise, claims 32-34 are also allowable as being dependent upon allowable claim 31.

Claim 35 recites a vertical power device structure including the specific structural limitations of providing that a semiconductor substrate having a drift region of first conductivity type therein and a transition region of first conductivity type that extends between the drift region and a first surface of the semiconductor substrate; first and second regions of second conductivity type that form respective P-N junctions with opposing sides of the transition region and constrict a neck of the transition region to a minimum width at a first depth that is greater than about 0.25 microns relative to the first surface; and wherein a product of a first conductivity type dopant concentration in the transition region at the first depth and a width of the transition region at the first depth is in a range between about $1 \times 10^{12} \text{ cm}^{-2}$ and about $7 \times 10^{12} \text{ cm}^{-2}$. The abovementioned structural limitations are neither anticipated by nor obvious over the prior art of record.

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Likewise, claims 36 and 37 are also allowable as being dependent upon allowable claim 35.

Claim 38 recites a Schottky diode device structure including the specific structural limitations of providing that a semiconductor substrate having a region of first conductivity type therein that extends to a first surface; first and second shielding regions of second conductivity type that form respective P-N junctions with opposing sides of the region of first conductivity type and constrict a neck of the first region of first conductivity type to first width at a first depth relative to the first surface; and wherein a product of a first conductivity type dopant concentration in the region of first conductivity type and the first width is in a range between about $1 \times 10^{12} \text{ cm}^{-2}$ and about $7 \times 10^{12} \text{ cm}^{-2}$. The abovementioned structural limitations are neither anticipated by nor obvious over the prior art of record. Likewise, claims 39 and 40 are also allowable as being dependent upon allowable claim 38.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Relevant Prior Art

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Tu et al., Malhi, Pfirsch, Boden, Jr. and Osanai each disclose semiconductor MOSFET devices.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Remmon R. Fordé whose telephone number is (571) 272-1916. The examiner can normally be reached on Monday-Thursday (8:00-6:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J. Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Remmon R. Fordé